Preparation technology of ultra-fine powders of *Auricularia auricular*

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Abstract: Conventional mechanical method and mechanical method combined with vacuum freeze-drying technology were used to make the ultra-fine powders of edible fungus (*Auricularia auricular*). The content of basic nutrients, amino acid, micro structure and their properties of raw edible fungus and the edible fungus powders obtained with the two methods were analyzed and compared. The granularity size and micro-structure of the pulverized samples were analyzed by SEM and TEM technology. The average granularity size of the edible fungus powder obtained with mechanical method was 1-5 μm, while that obtained with mechanical method combined with vacuum freeze-drying process was 0.5-1 μm. The ultra-fine powders of edible fungus obtained with the two methods had better water recovery capability and quality, and their preserving time was longer than that of raw edible fungus. All the properties of the ultra-fine powders of edible fungus obtained with the vacuum freeze-drying technology were evidently superior to that of the conventional mechanical method.

Keywords: *Auricularia auricula*; Edible fungus; Ultra-fine powders; Vacuum freeze-drying

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Introduction

Auricularia auricula (L.exHook.), called Jew's ear, black fungus and wood ear, is an edible fungus with full of nutrition such as amino acid, protein, iron, calcium and amylase. The edible fungus has high medical value in decreasing blood fat and preventing cancel. Although more and more preparation methods for improving the nutrition absorption of edible fungus have been developed, the preparation methods for enhancing medical value of edible fungus are rarely studied.

Ultra-fine powders preparation technology has been widely applied in food industry. Many edible animals, edible plants and food as medicine can be processed to ultra-fine powders, but their physical properties and microstructures are changed after this processing (Makio *et al.* 1993; Sheng 2003). Many of their properties such as surface absorbability, surface affinity, dispersion uniformity, solvency and fragrance preserving ability can be greatly improved. The nutrition absorption of edible fungus can also be improved after this processing, which increases the effect of medicine, improves utilization of effective component and increases the extraction efficiency (Chen 2002; Wang *et al.* 2000; Wei *et al.* 2003).

Mechanical method is a commonly traditional processing method for ultra-fine powders preparation, but few studies were carried out on the effect of processing on ingredient and efficacy of the material. In this paper, the advantages and disadvantages of both methods were analyzed on ingredient and efficacy of the edible fungus powders.

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Experiment methods

Key operation procedures of mechanical method for making ultra-fine powders

The cleaned raw edible fungus was put into a high speed pulverizer for pre-pulverizing treatment. The average granularity size of the edible fungus was 280-300 μm after treated. In F-170 pulverizer, the material was cut with high speed carbide knives, without producing heat and minor metallic particles, and the average size was 180-200 μm. Under negative pressure, the rough powder was pulverized by TF-160 vortex at extremely high speed. The average size of the pulverized material was 80-100 μm. Based on vibration principle, the striking acceleration speed of the ZM series ultra-fine pulverizer was 6 times that of conventional ball miller. The granularity size of the pulverized material can reach less than 10 μm. The procedure of mechanical method for making ultra-fine powders is as follows:

Raw material→ Preparation of edible fungus→Rough grinding→Further pulverizing→Vortex self-cooling pulverizing→Ultra-fine pulverizing→sample

Key operation procedures of mechanical method combined with vacuum freeze-drying technology

In the first pulverizing, water was added into rough-pulverized edible fungus powder by 180-200 μm. Then, the powder with water was grinded for twice respectively when the clearance between the rotator and the stator of the grinder was adjusted to the maximum and the minimum respectively. In this process, if excessive water is added, material will be difficult to condense before vacuum freeze-drying, still insufficient water will also affect the

grinding result. Repeated tests proved that the best result can be obtained when the volume of the added water is 2 times that of the volume of edible fungus powder. The granularity size of powders can be less than 50 μm. At last, in wet pulverizer, the granularity size of the treated powder of edible fungus can be less than 5 μm. After the powder was condensed in a vacuum rotary evaporator at 80 °C for 1.5 h, it was pre-freezed in refrigerator at -40 °C for 8 h and dried-freezed in vacuum freeze-drier for 5 h, after the ultra-fine powder of edible fungus was obtained. Procedure of mechanical method combined with vacuum Freeze-drying technology is as follows:

Raw material → Edible fungus preparation →Rough grinding → High speed pounding →Gelatine grinding→Wet ultra-fine pulverizing →Condensed (Vacuum freeze-drying (sample

Water recovery capability test

The samples obtained with both methods were soaked in two separate beakers for observing water absorbing state and speed.

Analysis of amino acid and vitamin

Granularity sizes and micro-structures of edible fungus samples obtained with both methods and raw edible fungus can not be described clearly through the optic microscope, and they were further researched through TEM analysis. The amino acid and vitamin contents of the samples obtained with both methods and raw material were analyzed with Model 835 amino acid analyzer and Model 10A high pressure liquid chromatography analyzer.

Results and discussion

Water recovery capability

Water recovery speed of the samples obtained with both methods was higher than that of the raw edible fungus. The reason is that edible fungus mainly relies on the gelatine between the mycelial cytoplasm and cell stroma for water absorption, while most gelatine exists in the middle part between the compact layers of the belly side and back side of the edible fungus. Thus, water of raw edible fungus can not be largely absorbed by the gelatine until it goes through the compact layers. The average cell diameters of the sample powder obtained with two methods were 1-5 μm (90%) and 0.5-1 μm (90%) respectively. On the contrary, the diameter of basidium cell of raw edible fungus was mostly 9-12 μm; the diameter of mycelial cell in raw edible fungus was usually less than 10 μm, mostly 1-3 μm, and the diameter of thinnest was 0.5 μm (Yang 2002; Yang 2003). The results showed that the cell structure has been destroyed; the substances composing cell have been released and become micro-particles. Thus the gelatine can absorb water directly and very quickly. Compared with the powder obtained with mechanical method, the powder obtained with mechanical method combined with ultra-fine pulverizing and vacuum freeze-drying absorbed water more quickly. The reason is that part of combined water in the freeze-dried sample had been removed and the water content of powder is lower than that of the powder obtained with mechanical method. When raw edible fungus absorbed sufficient water and was kept in natural condition, one and a half days later, viscous gelatine come out, but after 3 days, its quality went bad. Comparatively, when ultra-fine powder of edible fungus absorbed sufficient water and was kept in natural condition for more than 15 days, it had only slight delaminating. Another different point is that the ultra-fine powder of edible fungus has a performance of long tasting fragrance. The results of long time further observation showed when the water was vaporized naturally; the gelatine in the ultrafine-pulverized powder could make the particles of edible fungus integrate without quality deterioration.

It is obvious that ultrafine-pulverized powder of edible fungus has better preserving water and fragrance capability and its quality can be maintained for much longer time. The reason is that after granularity size is much reduced, relative surface area is significantly increased and the water content is reduced, which is conducive to dry storage.

TEM analysis

The biggest granularity size of powder obtained with mechanical method was less than 10 μm and the smallest is 0.5 μm, with an average granularity size of 1-5 μm(90%). The biggest granularity size of powder obtained with mechanical method combined with ultra-fine pulverizing and vacuum freeze-drying technology was less than 5 μm and the smallest is only 0.1 μm, with an average granularity size of 0.5-1 μm (90%).

The structure of the smallest cell scrap is shown in Fig.1 and Fig.2. TEM analysis indicates that there are a large number of irregular cell scraps in both samples, which means that most of the mycelial cells and basidium cells have been destroyed. In the visual field there are many irregular protein particles, celluloses and vacuoles, it is proved that the cell structure has been destroyed and the substances inside the cells have been released.

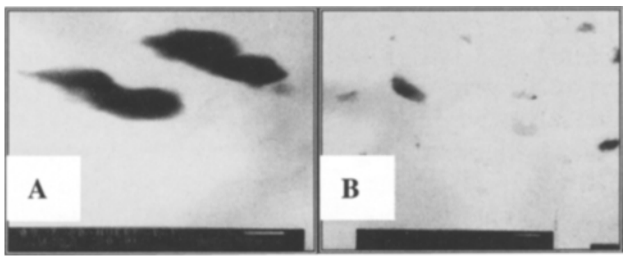

Fig. 1 The smallest irregular cell scrap obtained with two treating methods (×10,000)

A: conventional mechanical method; B: mechanical method combined with vacuum freeze-drying technology

Amino acid and vitamin analysis

After the raw edible fungus was processed with two methods, the total amino acid content in the edible fungus powder was increased (Table 1). The reason is that much more protein inside the cells was partly broken into small pieces while all protein could not be hydrolyzed completely in acid condition. In addition, the content of amino acid in the vacuum freeze-drying sample was higher than that in the sample obtained with mechanical method.

Vitamin test results showed that the content of VB_1 and VB_2 in ultra-fine pulverized powders was 4.1 mg/kg and 0.0073 mg/kg, while in raw edible fungus the average content of VB_1 was 2-4 mg/kg, VB_2 was 3-6 mg/kg (Table 2). It is obvious that the content of VB_1 kept unchanged, but the content of VB_2 was significantly reduced, which indicated that most VB_2 was destroyed after the edible fungus was superfine-pulverized.

Table 1. Analysis results of amino acid in edible fungus (%)

Type	Lys	His	Thr	Arg	Asp	Tyr	Glu	Pro	Gly	Ala	Cys	Val	Met	Ile	Leu	Phe	Ser	Total
A	0.72	0.36	0.52	0.7	0.89	0.5	0.84	0.55	0.45	0.66	0	0.48	0.16	0.39	0.72	0.42	0.2	8.47
B	0.54	0.27	0.67	0.41	1.1	0.42	1.22	0.46	0.53	0.86	0.29	0.65	0.16	1.1	1.0	0.69	0.63	11.0
C	0.65	0.37	0.90	0.65	1.38	0.48	1.68	0.38	0.82	1.23	0.45	0.95	0.20	1.12	1.02	0.59	0.9	13.7

Notes: *Test data provided by Heilongjiang Agricultural Science Academy Quality Supervision and Test Center for Cereal and Cereal Products.
A----Amino acid content in raw raw edible fungus; B---- Amino acid content in *Auricularia auricula* powders obtained with mechanical method; C---- Amino acid content in edible fungus powders obtained with mechanical method combined with vacuum freeze-drying technology.

Table 2. Analysis of vitamin content in edible fungus

Vitamin type	Vitamin content	
	Ultra-fine pulverized edible fungus /mg · kg^{-1}	Raw edible fungus /mg · kg^{-1}
V B_1	4.1	2-4
V B_2	0.0073	3-6

Comparison between the two methods

Edible fungus powders had better dispersing ability and better properties compared with the raw edible fungus. While the powders obtained with mechanical method combined with vacuum freeze-drying had better water recovery capability, smaller granularity size, longer preserving time and more amino acid content, compared with the powders obtained with only mechanical method, but the process is more complicated. Comparatively, the method of mechanical method combined with vacuum freeze-drying technology is better than mechanical method.

Conclusions

The ultra-fine edible fungus powders obtained with two methods has better water recovery capability and quality. Their preserving time is longer than that of raw edible fungus.

When edible fungus is pulverized to the granularity size of less than 5 μm, the cells are destroyed and ingredients such as protein, cellulose and amylase, etc., are released, and the nutrition can be absorbed directly or extracted more easily and quickly.

The average granularity size of the edible fungus powder obtained with mechanical method is 1-5 μm (90%), of which the smallest is 0.5 μm. The average granularity size of the edible fungus powder obtained with mechanical method combined with vacuum freeze-drying process after grinding is 0.5-1 μm (90%), of which the smallest is 0.1 μm.

After being ultra-fine pulverized, the total content of amino acid in the edible fungus is increased significantly, and 0.003% dissociative lysine is examined out, while VB_2 is largely destroyed.

The mechanical method combined with vacuum freeze-drying process is better than mechanical method.

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